

## NATURAL RESOURCES CONSERVATION SERVICE

### CONSERVATION PRACTICE STANDARD

#### DIKE (feet) CODE 356

##### DEFINITION

An embankment constructed of earth or other suitable materials to protect land against overflow or to regulate water.

##### PURPOSE

To permit improvement of agricultural land by preventing overflow and better use of drainage facilities, to prevent damage to land and property, and to facilitate water storage and control in connection with wildlife and other developments. Dikes can also be used to protect natural areas, scenic features, and archaeological sites from damage.

##### CONDITIONS WHERE PRACTICE APPLIES

Class I dikes are those constructed on sites where:

1. Failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, or main highways and high value land, crops, or other improvements.
2. Unusual or complex site conditions require special construction procedures to ensure satisfactory installations.
3. Protection is needed to withstand more than 12 ft. (3.7m) of water above normal ground surface exclusive of crossings of sloughs, old channels, or low areas.

Class II dikes are those constructed in highly developed and productive agricultural areas where:

1. Failure may damage isolated homes, highways, or cause interruption in service of relatively important public utilities.
2. The maximum design water stage against the dike is 12 ft. (3.7m).

Class III dikes are those constructed in rural or agricultural areas where:

1. The maximum design water stage against the dike is:  
Mineral soils - 6 ft. (1.8m)  
Organic soils - 4 ft. (1.4m)  
(Exclude channels, sloughs, swales, and gullies in determining the design water stage.)
2. Damages likely to occur from dike failure are minimal.

##### Scope

This standard applies to dikes or levees used to prevent or reduce flood damage to land and property, for flow control in conjunction with floodways, or to impound or regulate water for fish and wildlife management.

##### CRITERIA

###### All Dikes

In locating dikes, careful consideration shall be given to the preservation of natural areas, fish and wildlife habitat, woodland, and other environmental resources. If dike construction will adversely affect such values, concerned public agencies and private organizations shall be consulted about the project.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

**Legal requirements.** The cooperator (individual, group, or unit of government) shall (a) contact the appropriate county agency to determine if any permits are needed, (b) contact the U.S. Army Corps of Engineers for a 404 permit when constructing a structure on any stream which flows at least 180 days during the year.

**Protection.** A protective cover of grasses shall be established and maintained on all exposed surfaces of dike and other disturbed areas. Seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with requirements in the Hawaii Standard for Critical Area Planting (Code 342).

If vegetation will not control erosion, riprap or other protective measures shall be installed.

**Maintenance.** All dikes must be adequately maintained to the required shape and height. The maintenance of dikes must include periodic removal of woody vegetation that may become established on the embankment. Provisions for maintenance access must be provided.

### Class I Dikes

**Location.** Conditions to be considered in designing Class I dikes are foundation soils, property lines, exposure to open water, adequate outlets for gravity or pump drainage, and access for construction and maintenance. Mineral soils that will be stable in the dike embankment must be available.

**Height.** The design height of the dike shall be the design high water depth plus 2 feet (0.6m) of freeboard plus an allowance for wave height, whichever is greater. Design elevation of high water shall be determined as follows:

1. If dike failure is likely to cause loss of life or extensive high value crop or property damage, the elevation of design high water shall be that associated with the stage of the 100-year frequency flood or of the maximum flood of record, whichever is the greater.

2. If dike failure is unlikely to result in loss of life or extensive high value crop or property damage, the elevation of design high water shall be that associated with the peak flow from the storm that will insure the desired level of protection or the 50-year frequency flood, whichever is the greater.
3. If the dike will be subject to stages from more than one stream or source, the criteria indicated shall be met for the combination that causes the highest stage.
4. If the dike will be subject to tidal influence as well as streamflow, the streamflow peak shall be assumed to occur in conjunction with the mean high tide to determine the design high water depth.

The design height of the dike shall be increased by the amount needed to insure that the design top elevation will be maintained after settlement. This increase shall be not less than 5 percent.

**Interior drainage.** If inflow from the area to be protected by the dike may result in loss of life or extensive high value crop or property damage, provisions shall be included in the plans to provide protection against a 100-year frequency inflow hydrograph plus base flow and an allowance for seepage, and may include storage areas, gravity outlets, or pumping plants, alone or in combination.

If inflow from the area to be protected by the dike is unlikely to result in loss of life or extensive high value crop or property damage, storage areas, gravity outlets, or a pumping plant, alone or in combination, shall be included in the plans and designed to handle the discharge from the drainage area based on drainage requirements established for local area or the peak flow from the storm that will insure the desired level of protection, whichever is greater.

In sizing outlet works in combination with available storage, the minimum design storm duration for interior drainage shall be 10

days. If outlet works are designed using peak flood frequency flows without considering storage, the minimum design storm duration shall be 24 hours.

**Embankment and foundation.** The embankment shall be constructed of mineral soils, which when placed and compacted will result in a stable earthfill. No organic soil shall be used in the dike. Soils must have high specific gravity and be capable of being formed into an embankment of low permeability. The design of the embankment and specifications for its construction shall give due consideration to the soil materials available, foundation conditions, and requirements for resisting the action of water on the face of the dike and excessive seepage through the embankment and the foundation. The design of the embankment and foundation requirements shall be based on the length of time and height that water will stand against the dike.

Minimum requirements for certain features of the embankment, foundation and borrow pits are as follows:

Minimum to width of Class I dikes shall 10 feet (3 m) for embankment heights of 15 feet (4.6 m) or less and 12 feet (3.7 m) for heights more than 15 feet (4.6 m). If maintenance roads are to be established on the dike top, "turnarounds" or passing areas shall be provided, as needed.

Side slopes shall be determined from a stability analysis, except that an unprotected earth slope on the water side shall not be steeper than 4 horizontal to 1 vertical, if severe wave action is anticipated.

If dikes cross old channels or have excessively porous fills or poor foundation conditions, the land side toe shall be protected by a banquette or constructed berm. Banquettes shall be used to provide construction access and added stability if channel crossings are under water or saturated during construction. Banquettes shall be designed on the basis of site investigations, laboratory analysis, and compaction methods. The finished top width of the banquettes shall not be less than the

height of dike above mean ground, unless a detailed investigation and analysis show a different design is adequate. The finished top of the banquettes shall be not less than 1 foot (0.3 m) above mean ground and slopes away from the dike.

A cutoff shall be used if foundation materials are sufficiently pervious to be subject to piping or undermining. The cutoff shall have a bottom width and side slopes adequate to accommodate the equipment to be used for excavation, backfill, and compaction operations. It shall be backfilled with suitable material placed and compacted as required for the earth embankment. If pervious foundations are too deep to be penetrated by a foundation cutoff, a drainage system adequate to insure stability of the dike shall be used.

**Ditches and borrow pits.** Land side ditches or borrow pits shall be located so the hazard of failure is not increased. Ditches for borrow pits, when excavated on the water side of dikes, shall be wide and shallow. Plugs, at least 15 feet (4.6m) in width, shall be left in the ditches at intervals not greater than 400 feet (121.9m) to form a series of unconnected basins.

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

---

<u>Fill height</u>	<u>Minimum berm width</u>
Less than 6 ft. (1.8m)	12 ft. (3.7m)
More than 6 ft. (1.8m)	18 ft. (5.5m)

---

A drainage system shall be used if necessary to insure the safety of a dike. Toe drains, if used, shall be located on the land side and shall have a graded sand-gravel filter designed to prevent movement of the foundation material into the drain.

Subsurface drains shall not be installed or permitted to remain without protection, closer

to the land side toe of a dike than a distance three times the design water height for the dike. If subsurface drains are to be installed or remain closer than the distance stated, protection shall consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

**Pipes and conduits.** Dikes shall be protected from scour at pump intakes and discharge locations by appropriate structural measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible, or be equipped with antiseep collars.

All conduits through a dike below the design high waterline shall be equipped with antiseep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed waterline shall be equipped with a Dayton or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge conduits.

## Class II Dikes

**Design water stage.** The maximum design water stage permitted is 12 feet (3.7m) above normal ground level exclusive of crossings at channels, sloughs, and gullies.

If the design water depth against dikes, based on the required level of protection, exceeds 4 feet (1.2m), the design shall be based on at least a 25-year frequency flood. If this degree of protection is not feasible, the design shall approach the 25-year flood level as nearly as possible and planned fuse plug sections and other relief measures shall be installed where appropriate.

**Height.** The design height of an earth dike shall be the design water depth plus a freeboard of at least 2 feet (0.6m) or freeboard of 1 foot (0.1m) plus an allowance for wave height, whichever is greater.

The constructed height of the dike shall be the design height plus an allowance for settlement necessary to insure that the

design top elevation is maintained, but shall be no less than 10 percent of the design height.

**Interior drainage.** Provisions must be made for adequate drainage for the area to be protected by the dike.

**Cross section.** The minimum requirements for the cross section of the dike where fill is compacted by hauling or special equipment shall be as follows:

### Compacted Fills

Design water height		Minimum top width		Steepest side slope
(feet)	(meter)	(feet)	(meter)	
0 - 6	0 - 1.8	6	1.8	1 1/2:1
6 - 12	1.8 - 3.7	8	2.4	2:1

If soils or water conditions make it impractical to compact the dike with hauling or special equipment, dumped fill may be used and shall have minimum cross section dimensions incorporated in the fill as follows:

### Dumped Fills

Design water height		Minimum top width		Steepest side slope
(feet)	(meter)	(feet)	(meter)	
0 - 6	0 - 1.8	8	2.4	2:1
6 - 12	1.8 - 3.7	10	3.0	2 1/2:1

Side slopes of 3 horizontal to 1 vertical on waterside and 2:1 on land side may be used instead of 2 1/2:1 for both slopes.

The cross sections shall be strengthened or increased as required to provide additional protection against floods of long duration. The top width shall be not less than 10 feet (3m), if a maintenance road is planned on top

of the dike. "Turnarounds" or passing areas shall be provided as required on long dikes.

The side slopes shall be 3:1 or flatter on the waterside if severe wave action is expected, or if a steeper slope would be unstable under rapid drawdown conditions. Side slopes shall be 3:1 or flatter on both sides where permeable soils of low plasticity, such as SM and ML are used in construction.

A banquette (or constructed berm) shall reinforce the land side toe if a dike crosses an old channel or where excessively porous fill or poor foundation conditions justify such reinforcement. Such banquettes shall be used if, during construction, the channel crossing is under water or saturated.

The top width of the banquette shall be equal to or greater than the fill height of the dike above the top of the banquette unless a detailed investigation and analysis show a different design is adequate.

**Foundation cutoff.** A cutoff shall be installed if there are layers of permeable soils or layers creating a piping hazard through the foundation at a depth less than the design water depth of the dike below natural ground level. The cutoff trench shall be of sufficient depth and width and filled with suitable soils to minimize such hazard.

**Ditches and borrow pits.** Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

---

<u>Fill height</u>	<u>Minimum berm width</u>
Less than 6 ft. (1.8m)	10 ft. (3m)
More than 6 ft. (1.8m)	15 ft. (4.6m)

---

A land side ditch or borrow pit shall be far enough away from the dike to minimize any

hazard to the dike because of piping through the foundation.

For dikes having a design water depth of more than 5 feet (1.5m), the land side ditch or borrow pit shall be far enough away from the dike so that a line drawn between the point of intersection of the design waterline with the waterside of the dike and the land side toe of the dike meeting minimum dimensional requirements shall not intersect the ditch or borrow pit cross section.

**Pipes and conduits.** The dike shall be protected from scour at a pump intake and discharge by appropriate structural measures. A pump discharge pipe through the dike shall be installed above design high water, if feasible, or else equipped with antiseep collars.

All conduits through the dike below the design high waterline shall be equipped with antiseep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed waterline shall be equipped with a Dayton or similar coupling to prevent vibrations of the pumping plant being transmitted to the discharge conduits.

**Drains.** Drains shall be used where necessary to insure safety of dikes and shall be located on the land side, have a graded sand-gravel filter, and be designed and installed in accordance with Soil Conservation Service standards for such drains.

Field subsurface drains shall not be installed or permitted to remain without protection closer to the land side toe of a dike than a distance three times design water height for the dike. If such drains are to be installed or remain closer than the distance stated above, protection shall consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

### **Class III Dikes**

The design criteria shall be onsite conditions for mineral or organic soils as applicable.

**Top width.** Minimum top width is 4 feet (1.2m).

**Side slopes.** Minimum side slope is 2:1

**Freeboard.** The minimum freeboard is 1.5 feet (0.5m) or 1.0 feet (0.3m) plus wave height, whichever is greater. The constructed height shall be increased by the amount necessary to insure that the settled top is at design elevation but not less than 10 percent.

**Foundation cutoff.** A cutoff shall be installed if necessary to insure dike stability.

**Ditches and borrow pits.** Minimum berm widths between the toe and the dike and the edge of the excavated channel or borrow shall be two times the depth of the ditch but not less than 8 feet (2.4).

### **PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY**

#### **Water Quantity**

1. Effects upon components of the water budget, especially on volumes and rates of runoff, infiltration, evaporation and transpiration.
2. Potential for changes in rates of plant growth and transpiration because of changes in the volume of soil water.
3. Effects on downstream flows or aquifers that would affect other water uses or users.
4. Effects on the rate or volume of downstream flow to prohibit undesirable environmental, social or economic effects.

#### **Water Quality**

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.
2. Effects on the movement of dissolved substances to ground water.
3. Short-term, construction and maintenance related effects on the quality of water resources.
4. Potential for earth moving to uncover or redistribute toxic materials such as saline soils and make them available for undesirable effects on water or vegetation.
5. Effects on temperature of water resources to prevent undesired effects on aquatic and wildlife communities.
6. Effects on wetlands or water-related wildlife habitats.
7. Effects on the visual quality of water resources.

### **CONSTRUCTION PLANS**

Plans and specifications for construction of dikes shall be in keeping with this standard and shall describe the requirements for construction of the practice to achieve its intended purpose.

Plans should also specify recommended grass species, recommended planting method, and fertilizer recommendations for vegetation on exposed surfaces of the dikes and other disturbed areas.

For Class I dikes, construction specifications shall be developed for each job in accordance with National Engineering Handbook, Section 20.

The following Hawaii Dike Specifications can be used for the construction of Class II and III dikes.